**BRULE RIVER STATE FOREST MASTER PLAN FACT SHEET**

# *Land Use and Water Quality*

Different land uses can have a variety of impacts on streams and lakes through runoff and sedimentation. It is important to look at the relative impact of land uses throughout the watershed as a whole in order to gauge the potential impacts to water quality. Land use practices that create impermeable surfaces, expose soil, channel water rapidly to streams, and apply additional nutrients or chemicals to the soil have the greatest potential to impact water quality. These changes can affect both the amount of water reaching a stream or lake, and the type and amount of pollutants in that water. Increased runoff may produce floods, erode streambanks, alter stream vegetation, and scour desirable aquatic habitat. Non-point pollutants can include sediment, dissolved nutrients, plant material, animal wastes, and toxic chemicals. These may impact water quality through sedimentation, turbidity, eutrophication, and fluctuating water temperatures. (For more information, see the Water Resources Fact Sheet.) In addition to land use, factors impacting streams within a watershed include soil type, topography, and the intensity and duration of rainfall and snowmelt. In the watershed of the Bois Brule River, land use practices may either increase or decrease the frequent high, fast flows of water in the river that result in erosion of the streambank. These periods of peak flow will have the greatest impact on changes in the stream channel, since the main threat to the Brule is not the sediment carried to it from the uplands but the sheer volume and speed of delivery of water from within the watershed.

The Brule River watershed encompasses 128,000 acres. Land ownership in the watershed is divided between private land (43%), state land (29%), county land (17%) and private industrial forests (11%). The watershed includes a wide hilly area of mostly sandy soils over sand or gravel deposits in the south around the upper river (75% of the watershed) and a narrow valley of mixed sand and clay soils in the north around the lower river (25% of the watershed). The river is spring-fed, resulting in a steady water source year round.

The sandy and sandy/loamy soils of the lower river fall within the Bayfield Sand Barrens and Mille Lacs Uplands ecological landscapes. In these areas, rainfall tends to filter in quickly rather than run off as surface water. The topography of the sandy soils includes pitted outwash, through which much of the rainwater filters to lakes and other depressions instead of draining directly into the Brule River. Therefore, erosion and high overland flow are less of a threat in the upper Brule River watershed, though there is potential for localized erosion along roads, trails, and drainage ditches. Additionally, the sandy areas are more susceptible to groundwater contamination than areas with clay soil.

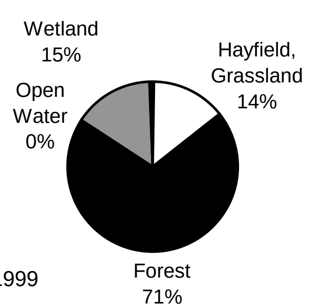
The clay soils of the lower Brule River watershed, however, lead to considerable high overland flow of water. In this area, which is part of the Lake Superior Clay Plain, water hits the clay surface and runs quickly into streams instead of soaking into the ground. Slopes along the river are steep in many places, and erosion of streambanks is common in high water conditions.

The streambanks appear to be clay, but actually contain sand under the clay surface. These steep, sandy banks are the source of much of the sand sediment found in the streambed of the Brule. While not the source of the sedimentation, the clay soils do turn the water reddish brown, and would do so in this watershed regardless of land use. However, certain land use practices increase the flow of water and result in greater streambank erosion and sedimentation reaching the Brule River.

The effects of land cover on streams are most prominent during large rainfalls, floods, and snowmelt (Fitzpatrick, et al. 1999; Verry, 1998). These frequent high flows result in increased hydraulic energy (the energy of the water) that cuts away at the sandy textured channel banks. Generally, less developed and more vegetated land reduce the flow of water to the Brule River.

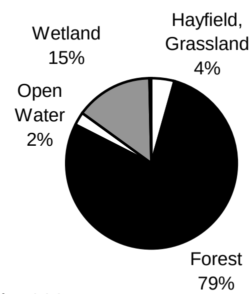
Land use and land cover types within the Brule River watershed include forests, wetlands, hayfields, residential developments, cropland, and roads. Within the watershed, the greatest potential impacts to water quality come from roads and construction projects, particularly within the clay plain. Residential areas also contribute to increased runoff and non-point pollution. Agricultural fields allow for more soil loss and water runoff than either hayfields/ grasslands or forests. Hayfields and grasslands that are not tilled have very low soil erosion, slightly higher than that of established forests, and lower than that of young forests (less than 15 years old). The abundance of wetlands and forest in the Brule River watershed helps protect water quality. Forests with considerable ground and canopy cover will prevent soil loss and runoff better than forested areas with less ground and canopy cover. The percentage of the clay and sandy regions of the watershed in each land cover type are shown in Figures 1 and 2. Due to the nature of WISCLAND satellite data, only large areas of a land use appear in these figures.

**Figure 1. Land cover types in clay soils in the Bois Brule watershed**




Source: Wiscland, 1999

**Figure 2. Land cover types in sandy soils in the Bois Brule watershed**




Source: Wiscland, 1999

One factor commonly used to rate the amount of soil loss due to different management practices is called the "c-factor." The c-factor is the variable in the Revised Universal Soil Loss Equation[1] that accounts for land use type, with higher numbers indicating activities that result

[1] The Revised Universal Soil Loss Equation is A = R* K* L* S* C* P, where
A = average annual soil loss, R = rainfall erodibility factor, K = soil erodibility factor, L = slope length factor, S = slope steepness factor, C = cover-management factor, and P = supporting practices factor.

in greater soil loss. C-factor values for several land types in the clay plain are listed in Table 1. The lower the c-factor, the lower the chance of harmful soil erosion entering the streams or river. Other factors involved in soil loss are slope, rainfall, and soil type. Some soil types are more likely to erode than others. This is represented in the equation by the “k-factor.” Soils that are more erodible have higher k-factor values than less erodible soils. Clay soils range from a k-factor of .43 to .28, while sandy soils range from .24 to .10. On average, sandy soils in this watershed will have approximately half the soil loss of clay soils, if all other factors including land use, slope, and rainfall remain the same.

**Table 1. Land use types, their relative contribution to soil erosion, and their abundance in the clay plain of the Brule River watershed**

| Land use type in the clay plain | C-factor for soil erosion based on land use type(1) | Percent of state-owned clay plain in each land use type | Percent of total clay plain in each land use type |
|---|---|---|---|
| Forests (stands greater than 15yrs old) | .001 | 61% | 70% combined |
| Forests (stands 15yrs old or younger) (2) | .01 - .15 | 16% | |
| Grasslands/hayfields | .004 - .01 | 10% | 14% |
| Roads and other bare areas | 1.0 | <1% | 1% |
| Agriculture | .05 - .15 | 0% | 0.4% |

(1) Source: USDA, 1987.
(2) The wide range of c-factors is due to two variables: ground cover and canopy cover. A forest at any age with high ground cover will have very little soil loss. Forests with little ground cover and few canopy trees will have greater soil loss.

For each land use or land cover type in the Brule River watershed, the following descriptions indicate how water may be impacted, how widespread the use type is in the watershed, and who generally owns land managed under each use.

**Roads:** Roads are the major source of increased runoff and erosion in the watershed. Roads with steep gradients, deep cut-and-fill sections, poor drainage, erodible soils, inadequate culverts, and stream crossings contribute to most of the sediment that runs off into streams and lakes (PUB WR-352-95-REV). Roads, like other impermeable surfaces, increase the amount of water that reaches a river system. They interrupt natural drainage patterns and channel water rapidly to streams. Roads built for forest management would have similar impacts as other temporary, unpaved roads. However, within the Brule River State Forest few roads are built for timber harvest or other management activities. Ten bridges cross the Brule River itself, and many bridges cross Brule tributaries, allowing greater water flow to enter the river. There are just over 1,250 acres of roads in the watershed. Most of these roads are built and maintained by local townships.

**Construction sites:** An average acre under construction delivers 600,000 pounds (30 tons) of sediment per year to downstream waterways. This causes more erosion than any other use. In general, 50% to 100% of the soil eroded from a construction site is delivered to a lake or stream, while for cropland the figure is only 3% to 10% (UW-Extension. 1997). Although there is some development in the Brule watershed, large acreages under construction are uncommon. Generally, construction sites are privately owned.

**Residential and Urban Development:** Residential areas have significant potential to impact water quality. Statewide, impermeable surfaces such as roads, roofs, and driveways channel water quickly into storm drains which often empty into nearby streams or lakes. This increased volume of water may carry sediment, nutrients including those from lawn fertilizer, organic matter such as lawn clippings and pet waste, bacteria, metals, pesticides, and other toxic chemicals (UW-Extension. 1997). Housing density in the watershed is low, ranging from two or fewer houses per square mile in much of the watershed, including industrial and state forest land, to greater than 16 houses per square mile near the towns of Brule and Lake Nebagamon (NRPC and WDNR. 2000). Due to the broad nature of land cover data collected for the WISCLAND data series, the exact acreage of residential land in the watershed is unknown.

**Cropland:** On a state-wide scale, agricultural cropping practices contribute significantly to non-point source pollution through runoff which may carry soil sediment, animal wastes, herbicides and pesticides, and high concentrations of nutrients such as nitrogen and phosphorus. In the Brule River watershed, however, less than 1% of the land is currently cropped. The area does have a significant history of agricultural practice. Much of the land surrounding the Brule River was cleared of forest and burned just before the turn of the century. A portion of it, especially in the clay plain, was then converted to cropland. These changes had lasting effects on channel characteristics of rivers in the region (Fitzpatrick. 1999). Over the past century, much of this cropland has returned to forest through planting or natural regeneration, and some areas are maintained as hayfields. Remnants of agricultural practices such as drainage ditches, which interrupt sheetflow and channel water quickly to streams, are still apparent in the watershed.

**Hayfields and grasslands:** In the Brule River watershed, some land is maintained in grasses and legumes and is harvested annually for livestock feed. These hayfields are located predominately in the clay plain. In the watershed's clay plain, 23% of private land, 10% of state-owned land, and 1% of county and industrial forests are maintained in grass or as hayfields according to WISCLAND satellite data and state forest reconnaissance data. Generally, hayfields are not tilled and the established grasses/legumes create a thick vegetation layer above ground and a widespread root layer just at the surface that keep soil erosion rates very low, just above those of forests. However, activity such as burning and spraying with herbicides may have some impact on water quality. A recent study of nearby Fish Creek concluded that future changes from pasture/ grassland or cropland to forest will help reduce flood peaks, which are double their pre-settlement rates for that river. However, if some portion not greater than 50-60% of a subwatershed remains "open" as opposed to forested, while at least 40% is in mature forest, snowmelt will be desynchronized (areas will melt at different times) and peak flow reduced (Verry, 1986).

**Wetlands:** Wetlands constitute 15% of the Brule River watershed (see Figures 1 and 2). These wetlands help to protect the water quality of the Brule River by trapping water and slowing its movement into the river and its tributaries. They also filter sediment and other pollutants from the water, while providing habitat for many species of plants and animals.

Approximately one half of the wetlands are in private ownership, while state and county forests each provide one fourth of the watershed's wetlands.

**Forests:** The vegetative components of forests, including trees, shrubs, plants, and their root systems, stabilize soils, absorb rainfall and slow the movement of water into nearby lakes and rivers. In the Brule watershed, about 80% of the sandy areas and 70% of the clay plain are forested. Within the clay plain, the state owns half of the forested acreage, while just over one third is privately owned, and the remainder is county and industrial forest. The percentage of private land harvested annually is not known, while about 1% of the state-owned acreage on the Brule River State Forest is harvested annually.

One of the greatest potential threats to water quality associated with timber harvesting is the construction of new forest roads. In the Brule River State Forest, new state forest roads are rarely built. All timber harvests in the Brule River State Forest take place more than 400 ft from the edge of the Brule River and are carefully designed to consider the slope of the terrain, the timing of the harvest, and the types of equipment used. These precautions exceed the recommendations laid out in Wisconsin's Forestry Best Management Practices (BMPs) for Water Quality handbook. In addition, forest management practices in the Brule River State Forest maintain approximately 85% tree cover in trees older than 15 years of age. This practice, also well above BMP guidelines, serves to slow snowmelt and reduce peak streamflow in the spring.

The Brule River is known throughout the region as an excellent scenic and recreational river. Its water quality and aquatic resources are monitored closely. Nonpoint source pollution may influence the water quality of the Brule, but at present it does not seriously impact animal and plant life. By understanding erosion processes, implementing Best Management Practices for each land use type, and encouraging land uses that benefit water quality, communities and land owners can work together on a watershed level to address potential problems of runoff and nonpoint pollution and continue safeguarding the water quality of the Brule River.

## References:


Fitzpatrick, et al. 1999. "Effects of Historical Land-Cover Changes on Flooding and Sedimentation, North Fish Creek, Wisconsin." United States Geological Survey Water-Resources Investigations Report 99-4083.

Northwest Regional Planning Commission and Wisconsin Department of Natural Resources. *Northwest Sands Landscape Level Management Plan*. December, 2000.

United States Department of Agriculture, Soil Conservation Service, Wisconsin. *Section I-C, Technical Guide.* Wisconsin, 1987-1988.

University of Wisconsin – Extension and the Department of Natural Resources. 1997. "Polluted Urban Runoff: a Source of Concern." DNR: WT-483-97.

Verry, E.S. 1986. Forest harvesting and water: the Lake States experience. *Water Resour. Bull.* 22(6):1039:1047.

Wisconsin Department of Natural Resources. 1995. Wisconsin's Forestry Best Management Practices for Water Quality. Publication number FR093.